Major Types of Risk Sources Perceived by Tomato Producing Smallholder Farmers the Case of Dugda District, East Shewa Zone, Oromia, Ethiopia

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Abstract
Risk is a central issue in rural areas that affects many different aspects of people's livelihoods in the developing world. Unless well managed, risks in agriculture can slow development and hinder poverty reduction. Smallholder farmers' perceptions of risk are therefore important in understanding their risk. Hence, this study aims at analyzing perceived risk source in tomato production using data collected from 167 tomato producing smallholder farmers from four kebeles of Dugda District, East Shewa Zone central rift valley of Ethiopia. The study combines data obtained from tomato producing smallholder farmers, Descriptive statistics, likert scale and Principal component analysis were employed for data analysis. A Likert scale, based on farmers' perception, was used to rank the various sources of tomato production risks. The mean scores results, derived based on Likert scales, indicated that production and market risks were perceived to be the major risk sources. Results show that using principal components analysis, multiple sources of risks were identified. Principal Components (PCs) explained that 58.2% of the variations were extracted. The major risk sources were also identified as production, investment, environmental, market and socio-economic risk by the surveyed smallholder farmers. The findings suggested that special attention should be given to pest and disease, market risk and investment risk in the study area, so that tomato producer smallholder farmers can benefit from improvement in risk management.
Keywords: Risk, Risk Sources, Smallholder farmer, PCA, Dugda District
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Introduction

Agricultural development is the key to economic development in many developing countries, especially India where a large proportion of the population relies on agriculture directly or indirectly for their livelihoods (Singh, 2008).

The economy of Ethiopia remains highly dependent on agriculture which contributes about 36 percent of GDP, seventy-eight percent of employment and ninety percent of exports (EEA, 2017). However, the agricultural productivity is low due to use of low level of improved agricultural technologies, risks associated with weather conditions, diseases and pests.

According to Ayinde, Omotesho and Adewumi (2008) the crops are subjected to high price and quantity risks with changing consumer demands and production conditions. Unusual production or harvesting weather or a major crop disease can influence badly the marketing system. Hence, knowledge crop producers' perception towards risk is important in designing strategies and formulating policies for agricultural development.

Perceptions steer decisions about the acceptability of risks and have a core influence on behaviors before, during and after a disaster (Rohrmann, 2008). To perceive risk includes evaluations of the probability as well as the consequences of a negative outcome (Weinstein, 1989).People normally evaluate risk and make decisions in relation to their whole life situation (Douglas & Wildavsky, 1982).

Tomato is one of the most popular produced and extensively consumed vegetable crops in the world (Grandillo, Zamir & Tanksley, 1999). It can be eaten raw in salads or as an ingredient in many dishes, and in drinks (Alam, Tanweer & Goyal,2007). Tomatoes and tomato-based foods provide a wide variety of nutrients and many health-related benefits to the body. Tomatoes production accounts for about 4.8 million hectares of harvested land area globally with an estimated production of 162 million tonnes (FAOSTAT, 2014).

Tomato production is a widely practiced activity in Dugda woreda of East Shewa Zones of Oromia, lying in the belt of the Great Rift Valley of the Horn of Africa. In this area tomato production is undertaken by smallholder farmers' and some large-scale commercial farming private investors. The area has a plain topography, with favorable weather conditions (moderately hot temperature), better availability of water (underground and river sources), and an advantageous location (in the central part of the country, with better infrastructure and high market potential) for tomato production. As a result, a large amount of tomato products are supplied to different markets in the area and to different parts of the country as a whole (Feyera, 2013).

There is much literature on perception of risk sources that affect farming operations. According to Flaten, Lien, Koesling, Valle and Ebbesvik (2005) the lack of relevant information on farmers' risk perceptions and their risk behavior present a challenging task for policy makers and researchers who want to create a proper risk management system to help farmers.

Empirical study by Agir, Saner and Adanacioglu (2015) noted that the aims to analyze farmers risk perceptions, risk management strategies in strawberry production in Menemen-Emiralem district of Izmir province in Turkey. The results of this study show that the most important risk resource that the strawberry farmers' perceive is arise from the lack of production capacity.

Using a survey of fruit and vegetable farmers conducted in six districts in the state of Uttar Pradesh India, Ali and Kapoor (2008) evaluated perceptions of farmers about risk face when producing fruits and vegetables. Farmers were asked to indicate perceptions of risks using a five point Likert scale with a specific source of risk. Sources of risk were classified into five dimensions: investment risks, socio-economic risks, environmental risks production risks and market risks.

Ali and Kapoor (2008), presented means and standard deviation for all risk sources evaluated, Within the investment risk categories they found fuel cost as one of the most important risks perceive by farmers; for the socio-economic risk category, poor linkages between research and extension was perceived to be the most important perceive risk; among the risks pest and diseases, as well as high input prices were found to be the most important risks perceived by producers in the product risk category and low price for products and high perishability of fruits and vegetables were perceived as the highest risks within the market risk category.

In Syria, Almadani (2014) based on survey data of 103 wheat-cotton and 105 pistachio farms in Syria, analyses farmer's risk attitudes and farmers' perceptions of risk and risk management strategies. Results show that Rainfall shortage and fuel price increase are the most important risk sources that threaten both wheat-cotton and pistachio cultivation.

In Ethiopia, there are few studies where farm level data sets have been used to identify the perceived importance of multiple risk sources. These include Belanieh and Drake (2003), Who identified determinants of smallholder farmers perceptions of risk in the Eastern highlands of Ethiopia, while the result presented in this study are based on data from two woredas in the Eastern highland of Ethiopia, The result illustrate that the conjunction of risk from the natural,economic and socio-political sources constitute a major challenge to livelihoods.

Kumilachew,Mengistu and Fekadu (2014) by their research on risks in vegetables production from the perspective of smallholder farmerst of Kombolcha District of Oromia Regional State Ethiopia suggested that production and price risks were generally perceived as the most important sources of risks.

While these studies have established sources of risk and show how farmers behave under uncertainty, less work has been done to identify how farmer perceive risk .The relative lack of information about perception of risk source of smallholder farmers under risky environment and their approach to it means there are few useful practical insights for policymakers, researchers, extension officers and advisers. Therefore: This paper seeks to explore 'perception of risk sources of tomato producing smallholder farmers' of Dugda district, East Shewa zone in Ethiopia

Methods and Materials

Both Primary and Secondary data was used in this study. In order to fulfill research objectives; to identify perceived risk sources by tomato producing smallholder farmers in the study area, a structured questionnaire method was employed to elicit information of primary data from the tomato producing smallholder farmers. Whereas Secondary data such as tomato production proportion of the kebeles were collected from woreda agricultural and rural development office

Sampling Procedure and Sample Size Determination

In order to undertake this study, DugdaWoreda was selected purposively since it has tomato production potential area. Then, a two stage sampling technique was used to select sample producers. Firstly, in consultation with the Woreda agriculture and Rural Development Office, the tomato producing Kebeles in the woreda was identified then; a total of four kebeles were selected from 17 kebeles of the Ditrict in wich tomato production takes place, based on number of tomato producing smallholder farmer. Secondly, a total of 167 sample smallholder farmers were selected randomly based on the proportion to the size of household population from the selected kebeles .

The selected four kebeles namely Bekele Girissa, Walda Kelina, Shumi Gamo, and Qorke Adi household population are 296. Using the below formula the total household sample size of respondent was 167 household. The Household sample respondent at kebeles level selected proportionally based on tomato producing household number.

In the second stage, simple random sampling technique was used to obtain sample respondents from each *Kebele*. Sample size was determined per each *kebele* proportionally to the total number of smallholder farmers.
Representative sample size is always determined by taking into account the level of precision, the level of confidence and the degree of variability in the attributes being measured. It is typically determined using statistical

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calculations. The sample size was determining using Kothari (2004) equation. The equation helps to determine the sample size when the population is size is finite. The equation is given by:

$$n=\frac{Z^2pq.N}{e^2(N-1)+Z^2.p.q}=\frac{1.96^2(0.5)(1-0.5)(296)}{(0.05)^2(296-1)+(1.96)^2(0.5)(0.5)}=\frac{284.6}{1.7}=167.4\approx 167$$

Where, n - desired sample size
Z - Values of standard variant at 95% confidence interval (Z = 1.96).
N= 296 Total number of tomato producing smallholder farmers.
P - Estimated proportion of tomato producing smallholder farmers
As the exact proportions of smallholder farmers participate in tomato production is not known a *prior*, P= 0.5 was used to obtain maximum number of sample household heads.
e=Margin of error considered is 5 % for this study

Method of data analysis
The researcher was used descriptive statistics like mean, standard deviation, frequencies and tabular analysis to examine and rank sources of risks based on farmers' perception. In addition, a five point Likert scale (responses on a 1-5 scale (1=no risk, 2=low, 3=medium, 4=high and 5=very high risk) has also used to rank risks.

Principal Component Analysis.
The primary purpose of PCA is data reduction based on a straight forward mathematical transformation of a covariance or correlation mix (Glorfeld, 1995). The central idea of principal component analysis (PCA) is to reduce the dimensionality of a data set consisting of a large number of interrelated variables, while retaining as much as possible of the variation present in the data set. This is achieved by transforming to a new set of variables, the principal components (PCs), which are uncorrelated.

The aim of the principal components method is the construction out of a given set of variables a^{i1} (i= 1, 2… k) of new variables (PC^n), called principal components which are linear combinations of the X^s the implicit form for computing the first principal component (PC^n) is: $PC^n = f(a^{ni}X^i \ldots\ldots a^{nk}X^k)$. (1)
This is given by the following expression, for the first PC:

$PC^1 = a^{11}X^1 + a^{12}X^2 + \ldots\ldots + a^{1k}X^k$ (2)

Where: PC_1 is the first principal component, a_{1k} is the regression coefficient for the k^{th} variable, that is the eigenvector of the covariance matrix between the variables, and X^k is the value of the k^{th} variable. This general model can be re-written as a functional equation.

$PC^1 = a^{11}X^1 + a^{12}X^2 + \ldots\ldots + a^{1k}X^k$

$PC^2 = a^{21}X^1 + a^{22}X^2 + \ldots\ldots + a^{2k}X^k$ (3)

. . . .

$PC^n = a^{i1}X^1 + a^{i2}X^2 + \ldots\ldots + a^{ik}X^k$

Where: a^{i1} ……………….. a^{ik} the component loadings; and

X^1 ………………… X^k the sources of risk

The coefficients a^{i1}, a^{i2}, …….. a^{ik} are called loadings and are worked out in such a way that the extracted principal components satisfy two conditions: (i) principal components are uncorrelated that means; Cov (PC^1, PC^2)=0 and,(ii) the first principal component (PC^1) has the maximum variance, subject to constraint that $a_{11}^2 + a_{12}^2 + \ldots + a_{1k}^2 = 1$, the second principal component (PC^2) has the next maximum variance subject to constraint that $a_{21}^2 + a_{22}^2 + \ldots + a_{2p}^2 = 1$ and so on.

Let Risk sources are $X_1, X_2, X_3, \ldots X_k$ in Tomato production, Y_i is principal component of risk source then, the principal component of risk source can be defined as a linear combination of the following equation

$Y^i = a^{i1} X^1 + a^{i2} X^2 + \ldots\ldots\ldots\ldots\ldots + a^{ik} X^k + e^i$ (4)

Where;

$X_1, X_2, X_3, \ldots X_k$ are source of risk in tomato production

$Y^1 \ldots\ldots Y_i$ are principal component of risk source

e^i, …….. are error terms use to indicate that hypothesized relationships are not exact .

a^{ik}, …….are loading of the risk source on the component

The Kaiser–Guttman rule (Kaiser, 1960) states that the number of factors to be extracted should equal the number of factors having an Eigen value greater than one''. The eigenvalue was used to determine how many components to retain.

Results and Discussion

Socio-economic characteristics of tomato producing smallholder farmers

Socio-economic characteristics of tomato producing smallholder farmers are given Table1. Average age of smallholder farmers is 34.29 and education level of the household is 5.82 years. Average family size is 4.84 people. Farming experience of Tomato producer household is 9.11 years in tomato production. The average farm sizes of the smallholder farmers were 0.67 hectares and the annual off farm income of the tomato producing smallholder farmers in the study area was 56,108.9 ETB annually.

Table1: Descriptive statistics of continuous variables

Variable	Mean	Std. Dev.
Age (in years)	34.29	5.97
Education (in years)	5.82	3.21
Family size (in numbers)	4.84	1.97
Extension contact (in numbers)	6.32	3.03
Farm size (in hectares)	0.67	1.78
Distance from market place (in KMs)	4.95	1.50
Farming experience(in years)	9.11	3.66
Off farm income (in ETB birr)	56,108.9	120,934

Source: survey data, 2019

Smallholder farmers surveyed in this study were mainly smallholder farmers with an average land holding of 0.67 hectares. The average distance to main market was 4.95 Kilometers from the market place .the average years in tomato producing of the household heads was 9.11.

Major Percieved Sources of risk of in Tomato Production

The perception of farmers on tomato production risks was assessed using the five point Likert scale; 1 meaning no risk and 5 meaning very high risk. This method of analysis is consistent with other studies (Ali and Kapoor, 2008; Kumilachew, 2014). Since risk perceptions are believed to guide responses, 14 sources of risk identified included in the questionnaire were analyzed in order to understand how farmers perceive them. Smallholder farmers' perceptions about the major sources of risks in tomato production are presented in Table 2. An important characteristic of production risk is that its level can be influenced by the level of input use. Therefore, high cost of input (mean 4.287) is the most important production risk, followed by pest and disease attack (mean 4.168).

Marketing of vegetables has become one of the critical areas where smallholder farmers are exploited (Ali and Kapoor, 2008). Variations in the market price fetched by the farmers are a reflection of the market risk. Market risks may be due to factors affecting the timely delivery of produce to. Consequently, farmers are forced to sell their produce to the traders at cheaper prices. Therefore, output price fluctuation (mean 4.126) is the most important market risk. Based on the smallholder farmers perceptions about the socioeconomic sources of risks in tomato production Lack of agricultural extension (mean 3.056) were found to be the top ranked sources of socioeconomic risks, followed by lack of credit (mean 2.772) and Lack of capital (mean 2.665).

Overall, the most common source of risk perceived by respondents is high cost of inputs as it is reflected in its high rank (mean 4.287 on a five point Likert-scale). The second important source of risk identified by respondents is pest and diseases attack with (mean 4.168). Output price fluctuations were ranked as the third with (mean 4.126) and Termites (insect attack) the fourth important tomato production risk sources with mean score of 3.832 and 2.46, respectively. The next most important sources of risks are rise in fuel price and uncertain climate.

Table 2: Perceived Sources of risks in tomato production

Variable	Mean	Std. Dev.
High cost of inputs	4.287	0.571
pest and diseases attack	4.168	0.627
Termites (insect attack)	3.832	0.862
Output price fluctuation	4.126	0.636
Uncertain climate	3.144	0.940
rise in fuel price	3.371	0.672
Lack of capital	2.665	0.773
Lack of improved seed	1.796	0.741
lack of credit	2.772	0.781
Labor in availability	1.749	0.637
Lack of agricultural extension	3.054	0.907
Shortage of rainfall	2.665	0.623
Lack of near Market	1.994	0.654
Lack of storage	2.467	0.805

Source: survey data, 2019

Principal Component Analysis Result

The central idea of principal component analysis (PCA) is to reduce the dimensionality of a data set consisting of a large number of interrelated variables, while retaining as much as possible of the variation present in the data set. This is achieved by transforming to a new set of variables, the principal components (PCs), which are uncorrelated, and which are ordered so that the first few retain most of the variation present in all of the original variables and the component analysis is performed using the principal component extraction method with varimax rotation. The Eigen values of selected components were greater than 1. Table 4 shows the total variance explained by the component extracted.

The Kaiser–Meyer–Olkin (KMO), also called the measure of sampling adequacy (MSA), indicates whether the other variables in the dataset can explain the correlations between variables. Kaiser (1974), who introduced the statistic, recommends a set of distinctively labeled threshold values for KMO and MSA.

The Kaiser-Meyer-Olkin measure of sampling adequacy is 0.708 is greater than 0.5, which is supported the use of principal component/factor analysis (Kaiser, 1974). The eigenvalues measures the amount of the variation explained by each PC and is largest for the first PC and smaller for the subsequent PCs. Accordingly, proportion of variance explained by the first 5 components is 58.2% from Table 4.

Table 3: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.708
Bartlett's Test of Sphericity	Approx. Chi-Square	406.19
	Df	91
	Sig.	.000

Source: Own Survey result (2019

Using Principal Component Analysis, these 14 sources of risk were reduced to five dimensions based on their component-loading score. The sorted rotated values of component loading with minimum value of 0.3 or more are accepted in Table 5 and five risk source components that explain58.2% of variance have been formed. Generally, component loading represents how much a component explains a variable.

Table 4: Total Variation explained by sources of risk component

Component	Eigenvalue	Difference	Proportion	Cumulative
PC1	3.159	1.648	0.226	0.226
PC2	1.511	0.170	0.108	0.334
PC3	1.341	0.251	0.096	0.429
PC4	1.090	0.042	0.078	0.507
PC5	1.047	0.081	0.075	0.582
PC6	0.967	0.025	0.069	0.651
PC7	0.942	0.135	0.067	0.718
PC8	0.807	0.097	0.058	0.776
PC9	0.709	0.033	0.051	0.827
PC10	0.676	0.082	0.048	0.875
PC11	0.594	0.106	0.042	0.917
PC12	0.487	0.093	0.035	0.952
PC13	0.394	0.119	0.028	0.980
PC14	0.275	.	0.020	1

LR test: independent vs. saturated: $chi^2(91) = 406.19$ Prob>chi2 = 0.0000
Number of parameters = 60
Number of observation = 167
Retained factors = 5

Source: Own computation result based on survey data (2019)

Extraction method: principal components analysis; rotation method: varimax with Kaiser Normalization. Component loadings greater than 0.3 are considered significant (Hair, Black Babin, & Anderson, 2013)

Interpreting the Component Solution in PCA

To interpret the solution, we have to determine which variables relate to each of the components extracted. We do this by examining the components loadings, which represent the correlations between the components and the variables and can take values ranging from-1 to +1. A high components loading indicates that a certain components represents a variable well. Subsequently, we look for high absolute values, because the correlation between a variable and a factor can also be negative. Using the highest absolute component loadings, we "assign" each variable to a certain components and then produce a label for each component that best characterizes the joint meaning of all the variables associated with it.

Various orthogonal rotation methods exist, all of which differ with regard to their treatment of the loading structure. The varimax rotation is the best-known one; this procedure aims at maximizing the dispersion of loadings within components, which means a few variables will have high loadings, while the remaining variables loadings will be considerably smaller Hair *et al.,* (2013).

Table 5:Results of varimax rotated component analysis for major of sources of risks

Variable	Component loadings					Uniqueness
	1	2	3	4	5	
PC1	0.783					0.315
PC2	-0.767					0.350
PC3	0.791					0.317
PC4			0.8128			0.318
PC5				0.635		0.502
PC6	0.686					0.480
PC7		0.7092				0.424
PC8		0.647			0.331	0.399
PC9	0.423	-0.332			0.435	0.410
PC10		0.545			-0.344	0.418
PC11					0.838	0.236
PC12				0.719		0.456
PC13			0.679			0.474
PC14	0.459					0.754

(Blanks represent (loading) <.3)
Source: Own computation result based on survey data (2019)

After varimax rotation, five components with eigenvalues greater than one emerged, accounting for 58.20 percent variance.

According to Tables 4 and 5, the number of variables of expectation values for the relevant Tomato production risk source data was reduced from 14 to 5 by applying the principal component analysis. Five components explain 58.2% of the total variance and discussed as below.

Production risks

The first principal component (PC1) explained 22.6% of the variance in the explanatory variables with fourteen of the estimated coefficients above 0.3 insect high input costs, lack of credit, attack by pests and diseases, rise in fuel price This shows that tomato production are subjected to input and production related risks Component 1 was related to 'production risk' because of the high loadings of risks that affect directly the tomato productivity. These risks are represented by the high cost of inputs, plant pests and diseases, termites or insect attack and rise in fuel price in the study area.

Sources of risk in tomato production are vulnerable to High cost of inputs (mean score of 4.287), Pest and disease attack (mean score of 4.168), Termittes or insect attack (mean score of 3.832). Risks due to rise in fuel price in tomato production (mean score of 3.371) have also emerged as an important concern in farmers' responses.

Investment risks

The second principal component (PC2) accounted for 10.8% in the smallholder farmers' rankings lack of agricultural extension, lack of capital, lack of improved seed, lack of credit and labor in availability.

Component 2 stands for the farmer's perception of the risk associated with the investment in tomato production. The mean and standard deviations in farmers' responses towards various drivers of investment risks in production of tomato were analyzed. The lack of capital has been perceived as the major source of investment risk in the tomato production.

The principal component loading (0.7092) for the variable lack of capital is the most important in the second component and indicates that the component strongly influences the variable

Environmental risks

The third principal component (PC3) accounted for 9.6% of the variance in the explanatory variables and shows that shortage of rainfall and uncertain climate were important variables. This component could be interpreted as reflecting environmental related risk. Therefore principal component 2 can be described as 'environmental risk' due to the high loadings associated with rainfall shortage and uncertain climate

The leading environmental sources of risks in tomato production included rainfall shortage, and un-certain climate. In fact, weather risks are the major sources of uncertainty in tomato production, as ranked by the highest mean score of 3.144 for un-climate. Impact of climate change is a serious concern for the farmers which can cause the occurrence of extreme weather events such as flood and drought along with temperature differences.

Marketing risks

The fourth principal component(PC4) explained 7.8% of the variance in the risk variables, the important risk variables are Output price fluctuations and lack of near market and this component is strongly associated with 'market risks' because of high loadings variables related to market risk. An output price fluctuation is the most important sources of risk for the fourth component. This indicates that tomato producing smallholder farmers' rank Output price fluctuations as a major risk sources in the tomato production.

Market risks are the result of variations in supply and demand for crops that are not subjected to price controls and the inability of controlled markets to respond timely and efficiently to changes in the market conditions (Acharya, 2004). Variations in the market price fetched by the farmers are a reflection of the market risk.

Consequently, the farmers are forced to sell their products to the traders at cheaper prices. The steep fall in market prices during the harvest season has been the most common grievance of the smallholder farmers. Output Price fluctuation of tomato is the biggest challenge to smallholder farmers and has been ranked as the highest risk with a mean score of 4.126. Lack of near markets to absorb the production is also risk source variable with mean score of 1.994 according to sample respondents.

Component loading in Output Price fluctuation of tomato was higher and needs urgent attention to safeguard them from the market risks.

Socio-economic risks

The fifth principal component (PC5) displays a variation of 7.5% in the smallholder farmers" rankings, lack of agricultural extension, lack of capital, lack of improved seed, lack of credit and labor in availability. And this component labeled as 'socio economic' risk. The principal component loading for the variable lack of agricultural extension is the most important in the fifth component.

The major sources of socio-economic risks in tomato production are associated with human resources and education-related issues. In addition, farmers face uncertainty about the economic consequences of their actions due to their limited ability to foresee factors such as change in prices and biological responses to different farming practices. The farmers' perceptions about the socio-economic sources of risks in tomato production of the study area are presented in Table 2. Rankings lack of agricultural extension (mean = 3.054), lack of capital (mean = 2.665), lack of improved seed (mean = 1.796), lack of credit (mean = 2.772) and labor in availability (mean = 1.749).

Here high component loading (0.838) of the variable (lack of agricultural extension (mean = 3.054), indicates that the components strongly influences the variable. This variable needs to be properly addressed in the scheme of risk management techniques.

Conclussion and Recommendations

The mean score results of smallholder farmers' perception on risk sources indicated that high cost of inputs, pest and disease attack, output price fluctuation, and termites or insect attack are the most important sources of risks in tomato production in the study area. Hence, to reduce such risks the following points are recommended.

The tomato producing smallholder farmers were perceive production risk as very important risk implying that they were not fully access to get input needed for production .

The agricultural sector should also be promoted as it contributes to income stability. Access to market should be enhanced and supported in order to sale production at market price. There is need to improve marketing infrastructures and institutions need to improve in rural areas in order to enable farmers to reduce transaction costs, unfair prices offered by local merchants, extraordinary price differentials within near distances and high price fluctuations over time

Conflict of Interest

The authors would like to declare that they have no interest of conflict and we want to disclose you that it is our original research work.

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